"HERMES will revolutionize the way bridge inspection is done...," Erol C. Kaslan, CalTrans

"If more reliable data was available, which resulted in even a 10 percent savings, $100 million would be saved annually just on bridge deck repairs ... HERMES has been designed to meet this need."

Dr. Steven Chase, Structures Division.
Federal Highway Administration

"We believe the HERMES has the potential to significantly change the way that we inspect bridge decks in California by providing a nondestructive, reliable, and quick method to assess bridge deck deterioration and damage."

Erol C. Kaslan, Section Chief
California Dept. of Transportation

"The LLNL radar imaging concept has a potential to be a major advance in concrete inspection technology and may greatly enhance our efforts of maintaining a safe and reliable service to our patrons."

Colin McDonald, Group Manager
Bay Area Rapid Transit (BART)

"... the radar imaging technology developed by LLNL has great potential in the evaluation of underground pipelines ..."

Allen Thomas, Executive Director
National Assoc. of Sewer Service Co.

HERMES in the news . . .

Health & Discovery

Science & Technology Review

LLNL Newsline

The HERMES Team is looking for partners

For more information, please contact the following:

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HERMES

Bridge Inspection Technology for the 21st Century

- *64 radars give 3 cm resolution*
- *Operates at highway speed*
- *"Sees" through asphalt*
- *Full deck coverage*
- *Safe for workers*

Federal Highway Administration

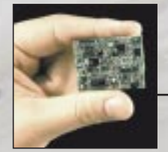
University of California
Lawrence Livermore National Laboratory

R&D 100
1998 Winner

1967
Silver Bridge collapses due to undetected cracks in a steel beam. This disaster prompts the federal government to require regular inspections of all bridges.

1969
Visual inspection, chain dragging, and coring become the current practices for bridge inspection nationwide.

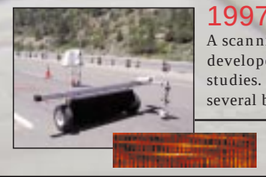
1993



Micropower Impulse Radar (MIR) is invented at LLNL. This patented new miniature radar technology enables over 100 new applications in the years to follow.

1995
MIR capabilities for NDE applications are demonstrated.
A new diffraction tomography algorithms is developed.
LLNL proposes a new high speed radar for doing HERMES.

1996
FHWA initiates the funding of the HERMES project. Design and construction begins.



1997
A scanning radar system is developed for phenomenology studies. Successfully tested at several bridges in California.

1998
HERMES prototype completed and delivered to FHWA, where it is currently undergoing testing.

2005

HERMES becomes a commercial product and changes the way that bridges are inspected. Quantitative information now drives the management of bridge maintenance programs nationwide. The life expectancy of bridge decks is substantially increased.

1960 1965 1970 1975 1980 1985 1990 1995 2000 2005

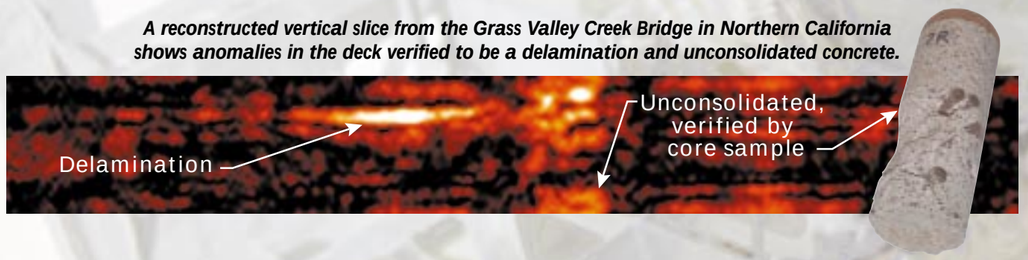
What is HERMES?

HERMES is a revolutionary new technology developed by the Lawrence Livermore National Laboratory (LLNL), under the guidance and sponsorship of the Federal Highway Administration (FHWA), for inspecting bridge decks at up to highway speeds. HERMES uses an array of 64 ultra-wideband radars for imaging and inspecting a two-meter-wide swath of a bridge deck in a single pass. Unlike other technologies for bridge inspection, HERMES generates a fully-3D picture of a bridge deck interior through a novel diffraction tomography technique. These images enable the operator to recognize concrete anomalies as deep as 30 cm. HERMES is a 1998 R&D 100 Award-winning technology that will lead to radical changes in bridge inspection methods, saving millions of dollars by providing more reliable diagnostics and reducing uncertainty in the repair contracting process.

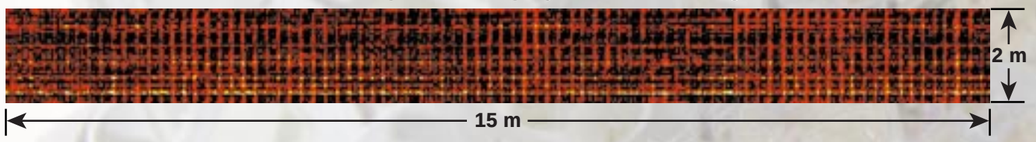
How does it work?

Each of 64 HERMES radars consists of a pair of small antennas for transmitting and receiving the ultra-wideband pulses. Each time a radar is fired, a sequence of pulses is transmitted into the ground to interrogate the dielectric properties of the bridge deck at different depths. Any abrupt dielectric change in the path of the pulses due to air voids, rebar, layer interfaces, or other non-homogeneities in the concrete, will cause a portion of the transmitted pulses to reflect back. These pulse echoes are then detected and stored in the HERMES on-board computer. The resulting data from all 64 radars is then processed off-line as a whole, much like a medical CAT scan, to generate a 3D picture of the bridge deck. HERMES visualization software allows the user to scan quickly through vertical or horizontal slices of the deck and search for anomalies indicating potential problem areas.

A reconstructed vertical slice from the Grass Valley Creek Bridge in Northern California shows anomalies in the deck verified to be a delamination and unconsolidated concrete.



A reconstructed horizontal slice 10cm-deep shows the top layer of rebar for a bridge in Livermore, California.



Benefits of HERMES

▼ *High-resolution 3D map*
HERMES high-resolution 3D map allows the operator to examine in detail the interior of the deck and improves the chances of early detection of defects, avoiding more severe and costly repairs.

▼ *Operates at highway speed*
Since HERMES can be driven over bridges at highway speeds, there is no need to set up expensive traffic control, engage safety vehicles or highway patrol, or slow down the traffic on already congested highways and bridges.

▼ *"Sees" through asphalt*
There is no need to remove the asphalt overlay since the ultra-wideband radars in HERMES can penetrate asphalt.

▼ *Full deck coverage*
With its 2m-wide array HERMES can inspect a two-lane bridge at 3-cm resolution in four passes.

▼ *Safe for workers*
Since HERMES is operated entirely from inside a truck, and without having to close the bridge, workers are not exposed to the hazards of traffic.

Comparison of Bridge Deck Inspection Techniques

Inspection Method →	Visible	Chain	GPR[b]	IR[c]	HERMES
Asphalt removal required?	No	Yes	No	Yes	No
Bridge closure required?	Yes	Yes	Yes	No	No
Top speed (m.p.h.)	5	5	< 55	25	55
Lane coverage (meters)	2	0.5	0.3	2	2
Penetration depth (cm)	0	5	30	< 10	15 - 30
Horiz. resolution (cm by cm)	1 x 1	100 x 100	10 x 10	30 x 30	3 x 6[a]
3D interior deck map	N/A	N/A	No	No	Yes

a. The numbers are cross-road and down-road, respectively. At low speeds, 3 x 1.5 is possible.
b. Ground-Penetrating Radar with surface coupling
c. Infrared imaging

Join the HERMES Team

Initial field trials show HERMES to be an effective research tool (see box below). So how do we make it available for common use? The first HERMES prototype was completed in September of 1998 and delivered to the Federal Highway Administration, where it is currently undergoing testing. This culminated 4 years of research and development and a combined investment by LLNL and FHWA of more than $4M. We are currently seeking state, local, or federal agencies, as well as businesses and universities, interested in teaming up and sponsoring a program to commercialize HERMES and improve its capabilities. Collaborators are sought with technical and scientific expertise in the area of bridge deck analysis/repair, radar systems manufacture, and packaging of radar with data acquisition and reduction systems. For further information see the contacts list on the back page.

HERMES In Action!

In May 1997, HERMES was first tested at the Grass Valley Creek Bridge in Northern California, which was scheduled for deck rehabilitation at a cost of $1.6M. HERMES data revealed significant problems which were later verified when the top asphalt layer was removed. The repair work had to be stopped since a complete deck replacement was required. This led to an extra one year delay and an additional cost of $1M. If HERMES data had been available before the initial bid, one year and $1M could have been saved on this one bridge alone!